TECHNICAL NOTES

US DEPARTMENT OF AGRICULTURE **NATURAL RESOURCES CONSERVATION SERVICE**

AGRONOMY – 63 revised **Albuquerque, New Mexico**

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NEW MEXICO DAIRY POND SIZING SOFTWARE

USE OF MICROSOFT EXCEL SPREADSHEET

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- **Purpose:** This note will help dairy planners use the New Mexico Dairy Pond Sizing Software (Microsoft Excel spreadsheet) to estimate a 2-month minimum storage requirement pond or an evaporative Pond. This software is for use in New Mexico. It does not estimate the volume needed for treatment lagoons since additional volume is needed for those pond designs. The can be download at: http://www.nm.nrcs.usda.gov/techserv/TechNotes/agro/ag63.xls

- **Background:** An Agricultural Feeding Operations/Confined Feeding Operation technical working group made up of NM State University, NM Environment Dept. (Ground Water and Surface Water Bureaus), Livestock Industry Groups, and NRCS have worked for at least three years to address the needs for Comprehensive Nutrient Management Planning. The group has considered using a spreadsheet from UT, National Software from Purdue, Animal Waste Management software from the NRCS Water and Climate Center in Portland, and some old software that has been used by NRCS field offices. Most of the programs we reviewed were complicated and data hungry. One of them did not allow use and management of our own data for NM. After this 3-year period, the technical group decided to use the software that has been in use in New Mexico by NRCS. This software has been updated from a prelude spreadsheet into a Microsoft Excel sheet.

- **General:** The software is very simple to use and requires very little inventory to size the storage pond(s). Its usefulness is limited to dairies where there is no frozen ground, little runoff from normal precipitation (16 inches or less), and fairly level land. The planning method follows the NRCS Animal Waste Field Handbook (AWFH), Chapter 10. Users should first visit the dairy site to inventory needed input data. Use the New Mexico inventory sheets from http://www.nm.nrcs.usda.gov/technical/water/cnmp-sample-plan/inventory-data-sheet.doc.

  Make sure that you have a computer with Microsoft Excel and internet access (to download the software) or a disk which includes the software files. You will also need a basic level of understanding of spreadsheets. Only the tan colored boxes allow data to be supplied. The clear boxes have formula or text that should not be changed.

  In October 2004 for version 1.5, we added the use of various screens or solid separation to the waste stream calculation. These separators now can be used to reduce the volume of the solids. A storage volume for sludge is now included in the pond sizing, and this requires the planner to discuss, with the dairy manager, the number of years between cleanouts.

The rest of this note will lead you through an example of how to use this software. Any problems with the software should be reported to one of the authors or the person in their position at the NRCS.

DATA NEEDED

- **Planning Data Sheet**

Dairy Name: Name of the dairy the plan is developed for.
Location: Location of the dairy
Dairy Manager: The person that can make the management decisions required for planning.
Planner: The name of the person developing the overall plan. This could be the CNMP planner or the specialist that developed the worksheet.
Flush System used?: This is a yes or no question with a pull-down. It turns off and on the flush part of the worksheet.
Number of milking cows: This is the number of milking cows that will use the system.
Average weight of cows: This is the average weight of the milking cows.
% waste from the milking center: Think of this as the time the milking cows spend on the area where the manure will end up in pond storage area. Typically this is about 15% of the time.
Wash water used in milking center: This is the amount of water used per cow in the milking operation. It can be a number from the Nutrient Mgt. Specification, or an amount from the water meter going into the milk house if it all flows into the waste stream.
Number of months of storage needed: Minimum here is 2 months. It may be wise to consider more storage if there is not enough soil moisture storage capacity available to receive additional water when there is no crop growing. The goal here is to have room in the soil for the pond water **without** leaching or runoff.
Flush water added: This is only used when there is an alley flush system. This is only added water not recycled water. The AWFH has some estimates. The dairy producer should have some idea.
Dairy Data for the Flush System: The next four rows of data are used in the flush system. The milking cows and weight come from the above section. The dry cows have the same weight as above.
Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

- **Lot Runoff Sheet**

Pond/Lagoon #: Type in an identifier for the pond being sized.
Practice Name: List the practice being designed (Pond 378, Waste Storage Facility 313, etc.).
Pond Location: Select the climate location for the structure from the pull down.
DRAINAGE AREA: Enter the acres of the watershed that will drain into the pond**.**
RUNOFF CURVE NUMBER: Runoff curves are used to determine how much runoff will come from the lot. Unpaved lots will use **90,** and paved or concrete areas will use **98.** If the lot is mixed, a simple weighted average can be done. Example: if there is 5 acre of concrete at a 98 and 20 acres unpaved at a 90. CN = [(5 ac X 98) + (20 ac X 90)]/25 ac = 91.6. This is a weighted average.
TIME OF CONCENTRATION: See Figure 2-2 on the Table-Fig tab to find the Tc using channel (or flow) length in feet and the change in elevation over the flow length.
CHANNEL-LOSS FACTOR: This will always be one for dairies.
UNIT DISCHARGE: Enter Figure 2-4 on the Table-Fig tab with the Tc and find the cfs/ac-in discharge.

DIRECT RUNOFF: See Figure 2-5 on the Table-Fig tab with the CN and annual precipitation to find Q in inches.
OUTPUT: The output used for sizing the runoff pond is the acre feet needed for the 25 yr, 24 hr storm.
Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

- **Pond Vol Sheet**

Pond Location (Climate): This is a pull-down that will select the annual rainfall and the percent lake evaporation by month to be used in the volume calculation.
Annual Lake Evap map: This is the annual lake evaporation at the site of the pond. Click on the Evap-NM tab and read evaporation from the map for the location being planned.
Pond/Lagoon Surface Area: This is the estimated amount of surface area of the pond at the mid depth of the pond storage volume. The sheet will give an estimate of the depth in feet for the storage period. Find this on the lower right hand side of the table. The goal here is to adjust the surface area to make a reasonable depth to build the pond. Since this depth represents only the storage volume but not storage for freeboard, storm rainfall and runoff and sludge, a practical depth for this sheet is 6 feet or less.
Note: This sheet calculate the storage required for greatest two months of storage over a year.
Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

- **Rec. Pond Size Sheet**

Note: This sheet can design either a square or rectangular pond.
ESTIMATE NUMBER OF YEARS BEFORE CLEANING POND: Planners must estimate the number of year before the pond will be cleaned. The dairy producer should make this decision based on his management and equipment available.
SOLID SEPERATION: If there are one or more separators in the waste stream they can be selected using the pull-down. Then the default value of separation can be adjusted as appropriate. This will calculate the volume of the solids delivered to the pond in one year.
SLUDGE VOLUME: The sludge volume is calculated by using a factor, listed in Chapter 10 of the AWMFH, for solid accumulation in lagoons. **Solid accumulation is based entirely on management of the waste stream and how the pond is dewatered.** If the dairy manager agitates the pond before dewatering, few solids will build up. If little or no separation is done and the pond is dewatered from the top without agitation, then solids will accumulate.
POND STORAGE CAPACITY: Shows the four required storage volumes and their total. The lot storm volume is only added into the total if this is a combined pond (one that captures water from the milking center, flush system, and feedlot). The user selects this option at the top of the sheet.
WASTE WATER STORAGE REQUIREMENT:
POND LENGTH: Enter the desired Length. An estimated length is given to start the process for a square pond.
POND WIDTH: Set by the calculation of the surface area from the Pond Vol sheet.
SIDE SLOPE: Enter the desired side slope. Slopes can be no steeper than 3:1.
POND Depth: Enter a depth (nearest 0.1 foot) to calculate the POND Volume. The spreadsheet compares this computed volume to the required volume, which is shown in the Pond Storage Capacity section. A note on the right tells the user that either the depth must be increased or the volume is ok.
STORAGE OF THE 25 YR-24 HOUR STORM:
STORM Depth: Enter a depth to calculate the STORM Volume. The spreadsheet compares this computed volume to the required volume. A note on the right again tells the user that either the depth must be increased or the volume is ok.

STORAGE OF SLUDGE:
SLUDGE DEPTH: Enter a depth to calculate the SLUDGE Volume. The spreadsheet compares this volume to the required volume. Again, a note on the right tells the user that either the depth must be increased or the volume is ok.
FINAL POND DIMENSIONS:
Note: This section summarizes the depth, length, width, and surface area of the pond.
DEPTH OF 21 DAY STORAGE WITHIN THE 60 DAY STORAGE:
Depth of 21-Day Storage: Enter a depth to calculate the 21-day storage volume. The spreadsheet compares this to the required volume and display a note telling the user to either increase the depth or the depth is ok. This volume is a portion of the 60 day storage and is required to remain empty by Surface Water Bureau of the NMED.
CROSS SECTION:
Note: Shows a not to scale graphic of the pond cross section.
Pond Depth (Staff Gauge) – Volume Table: Provides a table of depth versus volume. This table is used to estimate volumes in the finished pond.
Lining Area: Estimates the area (in square feet and square yards) of lining material needed.
System Planning Notes: Write any notes needed to explain the calculations.
Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

- **Lot Runoff Pond Sheet**

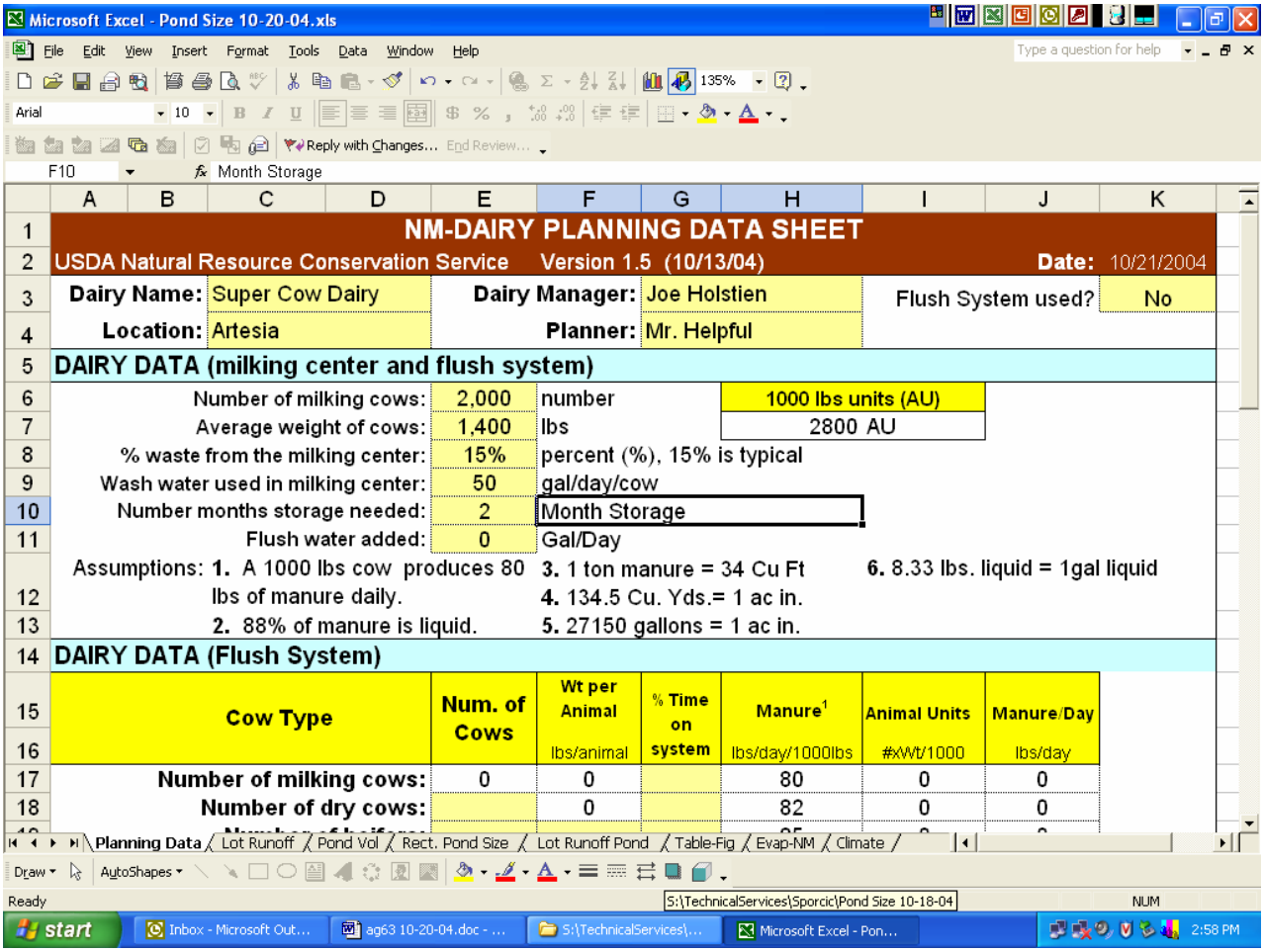
Note: This sheet operates very similar to the Rect. Pond Size sheet and is used to size runoff ponds or any other ponds needed for the dairy. Sometimes the milking center waste is stored in more than one pond. This sheet can size the volumes of each pond assuming that the established depth on the single pond design (Rect. Pond Design) is maintained in the three ponds.
Note: For Lot Runoff Ponds and other ponds, changes may be needed on the Lot Runoff or Pond Vol sheets. The user must revisit those spreadsheet tabs and print all changes in order to fully document each pond design.
Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

- **Example Problem**

Inventory Data: The Super Cow Dairy managed by Joe Holstein has a 2000 cow milking herd near Artesia, NM. Mr. Holstein wants to size a pond for 2 months storage of his milking center manure and determine how large the runoff pond for his barn lot will have to be. He wants the runoff pond to be a square and the milk center to be a square shape. We have visited the site and determined that there is about 15 acres of unpaved lot where the cows spent about 85% of the time. The rest of the time the cows are in the milking area (15%), and he uses about 50 gal/cow in his spray wash system (100,000 gal/day (water meter)/2000 cows) = 50 gal/day. It is about 1000 ft across the lot in the direction the water flows and the slope is about 1%. The average weight of the cows is 1400 lbs. He plans to clean the pond every five years. He thinks that an incline screen will save about 60% of the solids in the waste stream.

Step 1 – Open the NM-Dairy Planning Excel spreadsheet, select the **Planning Data** sheet, and enter the row 3 and 4 data: Dairy Name, Dairy Manger, Location, Planner, and No for the Flush System Question.

Step 2 – Enter the Dairy Data on row 6 through 11: Number of cows, weight per cow, time at the milking center, wash water added, number of months of storage, and zero for flush water added. Flush data would be added if the dairy uses a flush system (Be sure to enter "yes" in the box for flush system on row 3).



Microsoft Excel - Pond Size 10-20-04.xls

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F10 Month Storage

1	NM-DAIRY PLANNING DATA SHEET										
2	USDA Natural Resource Conservation Service Version 1.5 (10/13/04)									Date:	10/21/2004
3	Dairy Name:	Super Cow Dairy			Dairy Manager:	Joe Holstien			Flush System used?		No
4	Location:	Artesia			Planner:	Mr. Helpful					
5	DAIRY DATA (milking center and flush system)										
6	Number of milking cows:	2,000	number			1000 lbs units (AU)					
7	Average weight of cows:	1,400	lbs			2800 AU					
8	% waste from the milking center:	15%	percent (%), 15% is typical								
9	Wash water used in milking center:	50	gal/day/cow								
10	Number months storage needed:	2	Month Storage								
11	Flush water added:	0	Gal/Day								
12	Assumptions: 1. A 1000 lbs cow produces 80 lbs of manure daily.		3. 1 ton manure = 34 Cu Ft				6. 8.33 lbs. liquid = 1gal liquid				
13	2. 88% of manure is liquid.		4. 134.5 Cu. Yds.= 1 ac in.								
			5. 27150 gallons = 1 ac in.								
14	DAIRY DATA (Flush System)										
15	Cow Type	Num. of Cows	Wt per Animal	% Time on system	Manure[1]	Animal Units	Manure/Day				
16			lbs/animal		lbs/day/1000lbs	#xWt/1000	lbs/day				
17	Number of milking cows:	0	0		80	0	0				
18	Number of dry cows:		0		82	0	0				

Planning Data | Lot Runoff | Pond Vol | Rect. Pond Size | Lot Runoff Pond | Table-Fig | Evap-NM | Climate

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Step 3 – Print this Planning Data tab before moving to the next sheet (or tab).

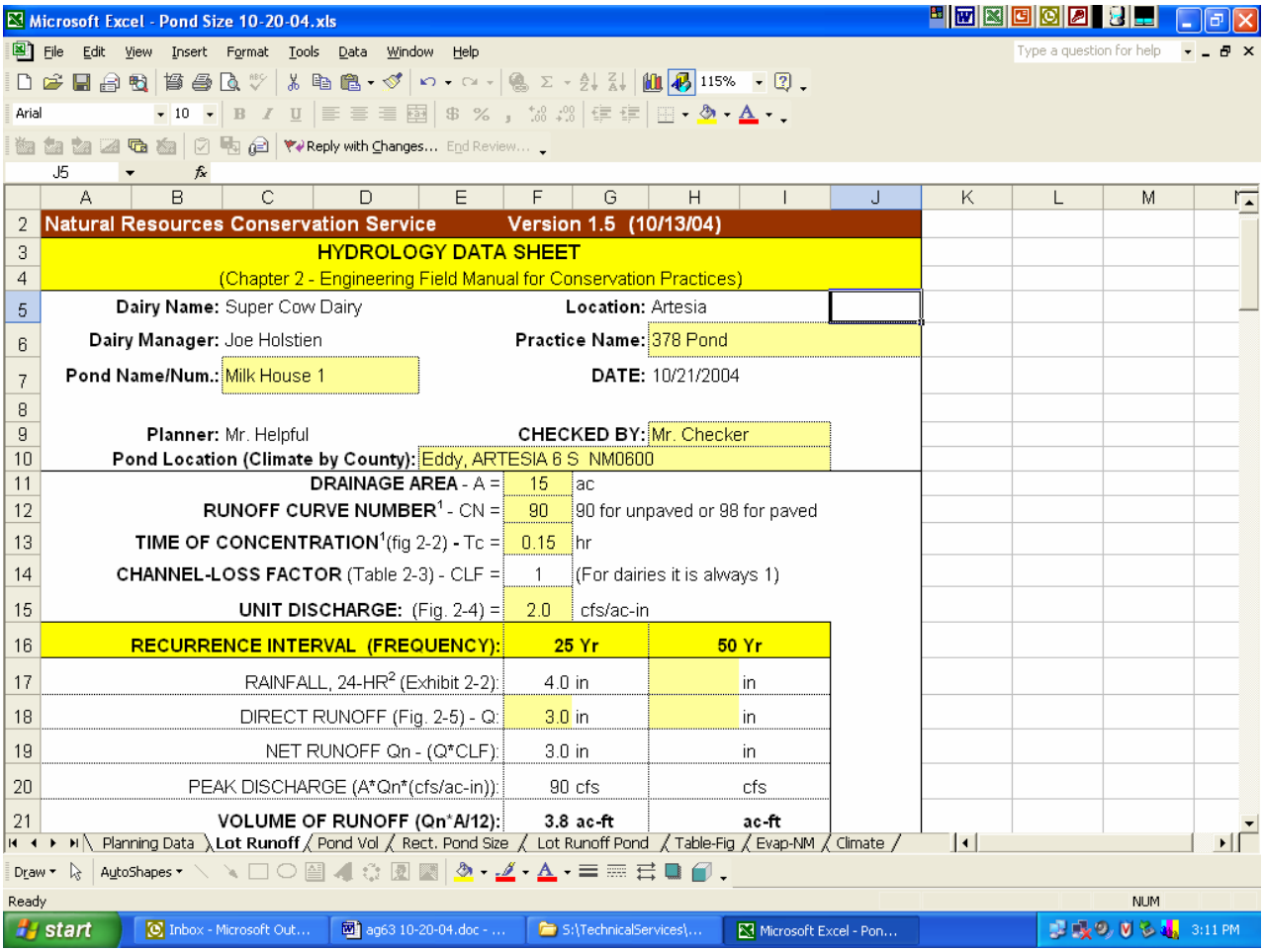
Step 4 – Change to the **Lot Runoff** sheet. Identify the Pond type in the Pond Name/Num. filed (for example: Milk House 1 or Runoff Pond), and in the Practice Name field, enter the practice number and name (for example, 378 Pond). Enter 15 acres for the drainage area. Enter 90 as the CN number. Click in the yellow box to the right of Pond Location (Climate by County) and use the dropdown list to select the climate station closest to the pond's location. For our example, select "Eddy, Artesia."

– Find the time of concentration (Tc) from Figure 2-2 on the Table-Fig tab. Use a channel length of 1000 ft (distance across the lot) and a change in elevation of 10 ft. (1% slope over 1000 ft. = 1000 x 1% = 1000 x 0.01 = 10 ft of elevation difference). For our example and from Figure 2-2, Tc is 0.15 hours. Enter this in the Tc box.

– To determine the Unit Discharge, use Figure 2-4 on the Table-Fig tab. On the graph use the Tc value of 0.15 hours and read 2.0 cfs/ac-in. Enter 2.0 in the Unit Discharge box.

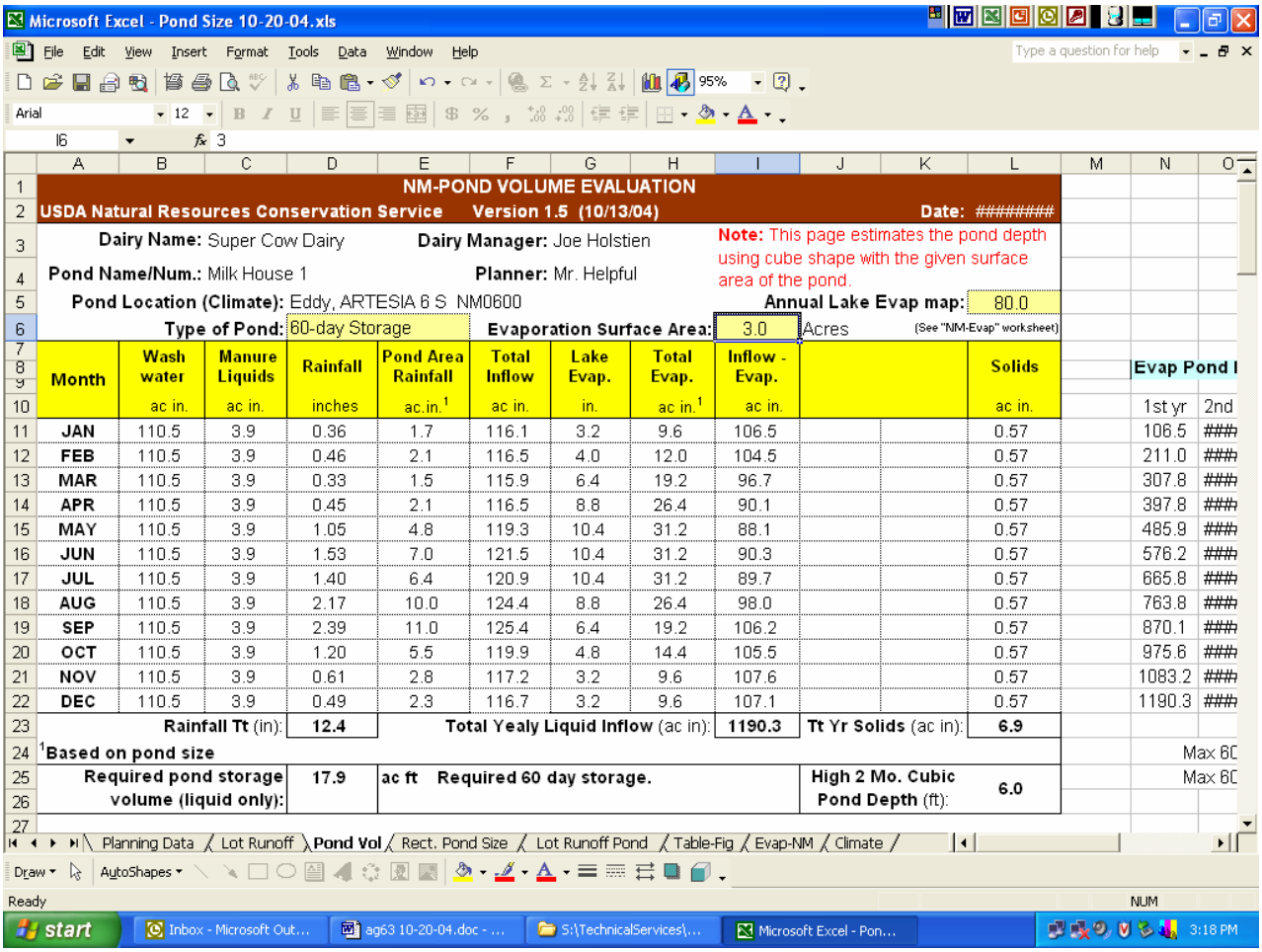
– To determine Direct Runoff (Q), use Figure 2-5 on the Table-Fig tab. Along the bottom of the graph find 4.0 inches (storm rainfall for our example, see cell F19), extend upward to the CN line (90 in our example), and read Q as 3.0 inches. Enter 3.0 inches in the Q box.

– For this example, we do not need to figure the 50-yr storm. However, when it needs to be computed, the user will need to find the 50-year, 24 hour rainfall from Exhibit 2-2 of NM Chapter 2 (2/85) of the Engineering Field Handbook, which is titled: "Peak Rates of Discharge for Small Watersheds." The user may also use the NOAA Atlas for New Mexico. Direct Runoff is found using Figure 2-5 on the Table-Fig tab of this spreadsheet.



Step 5 – Print this Lot Runoff tab before moving to the next sheet (or tab).

Step 6 – Change to the **Pond Vol** sheet. Select 60 day storage. Move to the Annual Lake Evap map cell and enter 80.0 inches per year. This is the annual lake evaporation found on the Evap-NM tab for the location of the pond. Look at the High 2 Mo. Cubic Pond Depth in cell L25 and adjust the Evaporation Surface Area until the depth is reasonable. Since this depth represents the volume of required storage but does not include volumes for freeboard, storm runoff, or sludge, a practical limit for this depth is about 6 feet. For our example, use 3.0 acres which computes a depth of 6 feet. Note that this volume calculation assumes vertical side slopes. Also note that the required pond storage volume is computed at the bottom of this sheet. For our example, it computes 17.9 ac-ft as the required 60-day (2-month) storage.



Microsoft Excel - Pond Size 10-20-04.xls

NM-POND VOLUME EVALUATION

USDA Natural Resources Conservation Service **Version 1.5 (10/13/04)** **Date:** #########

Dairy Name: Super Cow Dairy **Dairy Manager:** Joe Holstien

Pond Name/Num.: Milk House 1 **Planner:** Mr. Helpful

Pond Location (Climate): Eddy, ARTESIA 6 S NM0600

Type of Pond: 60-day Storage **Evaporation Surface Area:** 3.0 Acres (See "NM-Evap" worksheet)

Annual Lake Evap map: 80.0

Note: This page estimates the pond depth using cube shape with the given surface area of the pond.

Month	Wash water ac in.	Manure Liquids ac in.	Rainfall inches	Pond Area Rainfall ac.in.[1]	Total Inflow ac in.	Lake Evap. in.	Total Evap. ac in.[1]	Inflow - Evap. ac in.		Solids ac in.	Evap Pond I 1st yr	2nd
JAN	110.5	3.9	0.36	1.7	116.1	3.2	9.6	106.5		0.57	106.5	###
FEB	110.5	3.9	0.46	2.1	116.5	4.0	12.0	104.5		0.57	211.0	###
MAR	110.5	3.9	0.33	1.5	115.9	6.4	19.2	96.7		0.57	307.8	###
APR	110.5	3.9	0.45	2.1	116.5	8.8	26.4	90.1		0.57	397.8	###
MAY	110.5	3.9	1.05	4.8	119.3	10.4	31.2	88.1		0.57	485.9	###
JUN	110.5	3.9	1.53	7.0	121.5	10.4	31.2	90.3		0.57	576.2	###
JUL	110.5	3.9	1.40	6.4	120.9	10.4	31.2	89.7		0.57	665.8	###
AUG	110.5	3.9	2.17	10.0	124.4	8.8	26.4	98.0		0.57	763.8	###
SEP	110.5	3.9	2.39	11.0	125.4	6.4	19.2	106.2		0.57	870.1	###
OCT	110.5	3.9	1.20	5.5	119.9	4.8	14.4	105.5		0.57	975.6	###
NOV	110.5	3.9	0.61	2.8	117.2	3.2	9.6	107.6		0.57	1083.2	###
DEC	110.5	3.9	0.49	2.3	116.7	3.2	9.6	107.1		0.57	1190.3	###
		Rainfall Tt (in):	**12.4**		**Total Yealy Liquid Inflow** (ac in):			**1190.3**	**Tt Yr Solids** (ac in):	**6.9**		

[1]**Based on pond size**

Required pond storage volume (liquid only): **17.9** ac ft **Required 60 day storage.**

High 2 Mo. Cubic Pond Depth (ft): **6.0**

Max 60

Max 60

Planning Data | Lot Runoff | Pond Vol | Rect. Pond Size | Lot Runoff Pond | Table-Fig | Evap-NM | Climate

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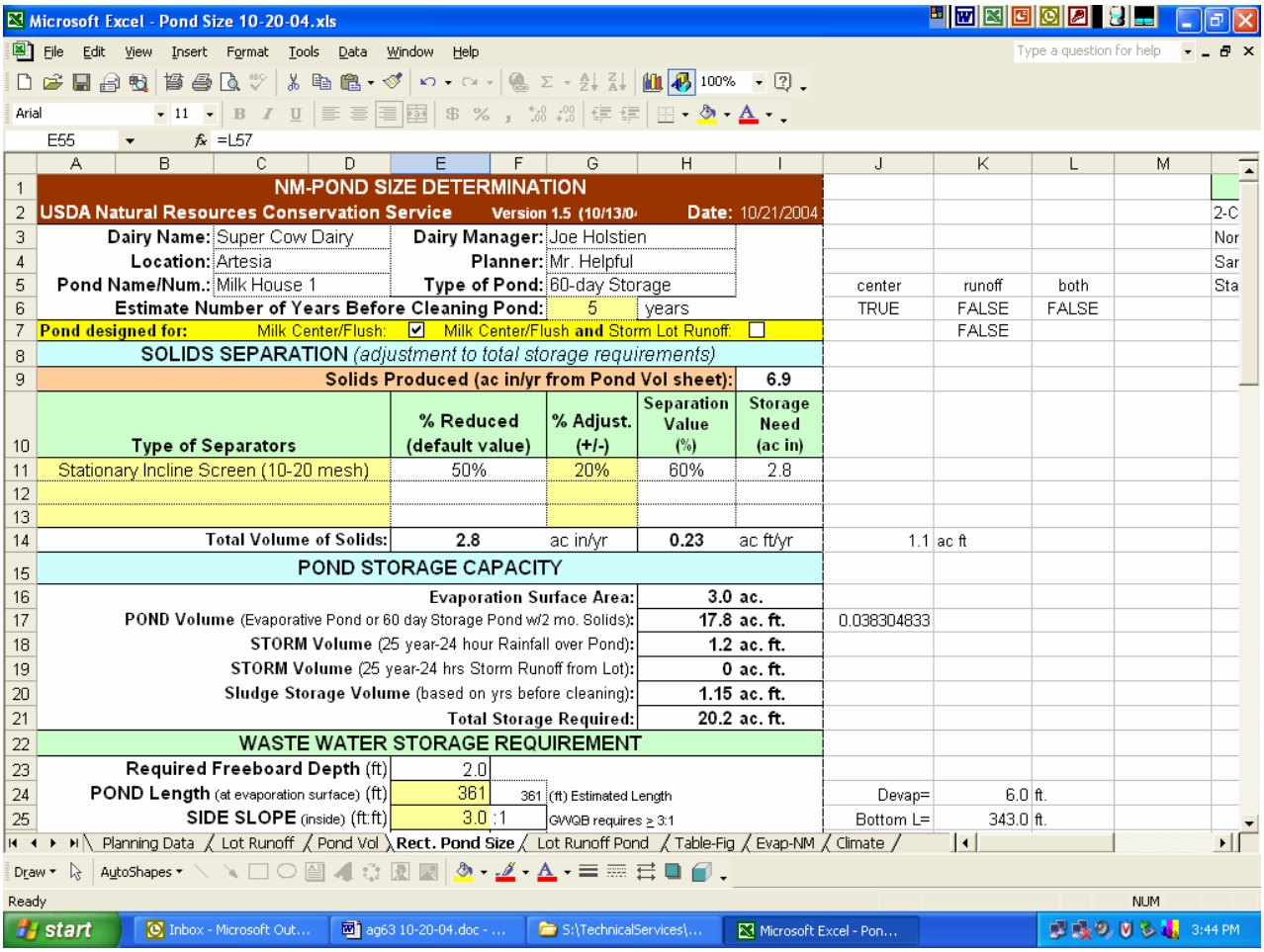
Step 7 – Print this Pond Vol tab before moving to the next sheet (or tab).

Step 8 – Size the two needed ponds. Move to the **Rect. Pond Size** sheet. Enter the number of years between pond cleanings. Select the appropriate "Pond designed for:" box. For our example, click the box following "Milk Center/Flush." This will place a check mark in the box. Next select the type of separator using the drop down menus. For this example, select the incline screen separator, and adjust the separation value using the pull down adjustment, use +20%. Note that the required 60-day storage is 17.9 ac ft (brought from the Pond Vol tab).

– The next three calculations use a trial and error method to balance computed pond volumes with the required storage volumes while establishing a shape fits within site requirements. Enter the freeboard requirement, which is most likely 2.0 feet.

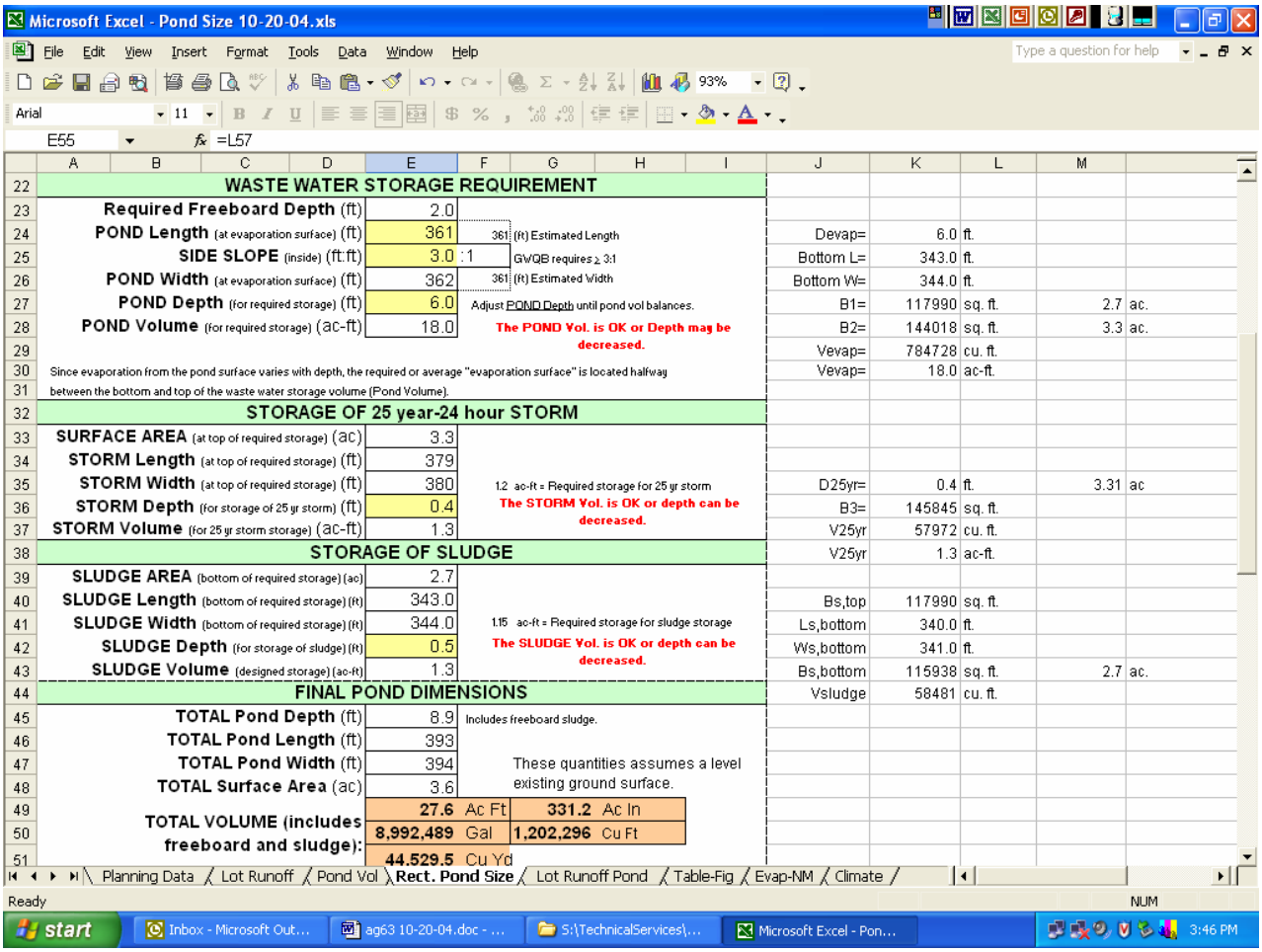


Step 8 (Continued) – The first required storage volume is the waste water storage. Enter a POND Length and side slope. The spreadsheet calculates the POND Width. Enter a depth using feet and tenths of a foot. The sheet calculates the volume and compares it with the required volume shown in the POND STORAGE CAPACITY section and displays a note, in red, which directs the user to either increase the depth or accept the depth as ok. In our example, enter 361 for length, 3 for side slope, and 6 for depth. The calculated volume is 18.0 ac ft which is slightly larger than 17.9. The user can check a depth of 5.9 feet, but, in this example, it will not provide sufficient storage.

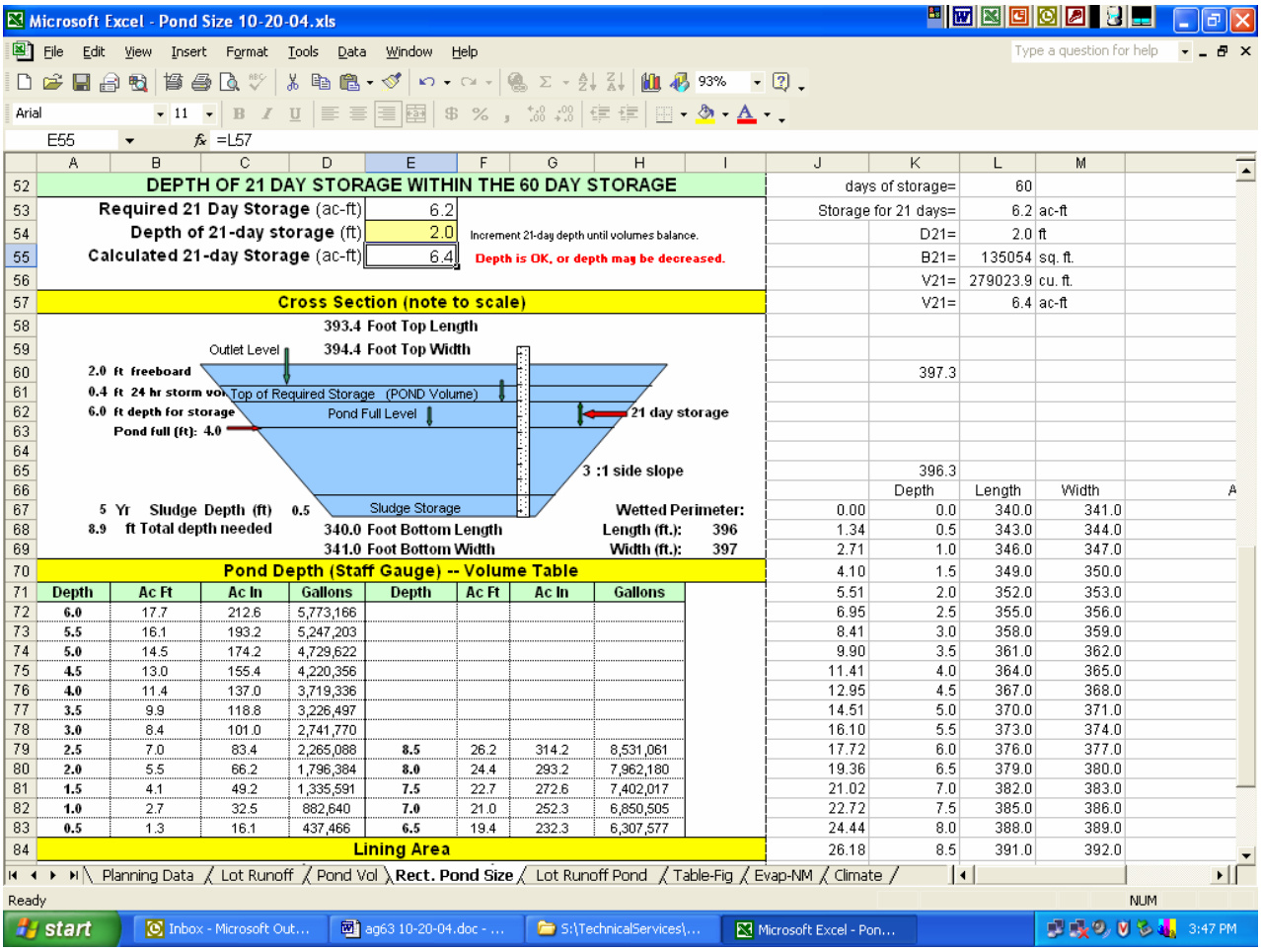
– Next set the storage volume for the 25-year, 24-hour storm. This volume includes the rainfall falling on the surface of the pond and runoff from a feeding lot, if included on row 7 above). Enter a depth to calculate the pond volume allocated to storm water. The spreadsheet compares the computed volume to the required volume shown in the POND STORAGE CAPACITY section and, by red note, directs the user to increase depth or accept current depth. For this example, 0.4 ft balances the computed and required volumes.

– The last required volume is for storage of sludge. Enter a depth and adjust that depth until the computed sludge volume balances with the required volume. For our example, 0.5 foot provides the required storage.

– The above calculations are summarized in the FINAL POND DIMENSIONS section. Note that the Total Pond Depth is almost 9.0 feet compared to the initial 6.0 feet calculated on the Pond Vol tab. Also note that the TOTAL Pond Length and Width is 393 ft. x 394 ft. compared to the 361 x 362 initially used.



Step 8 (Continued) – The last step is to establish the 21-day storage depth. As before, the user changes the depth while the spreadsheet compares the computed and required volumes and, by note, directs the user to increase the depth or accept the computed volume. For our example, 2.0 feet is the proper depth. Print the design sheet for the milk center pond. Note that with top Length and Width is increased to 394 ft by 394 ft because of the 9 feet depth including the freeboard requires the additional top width.



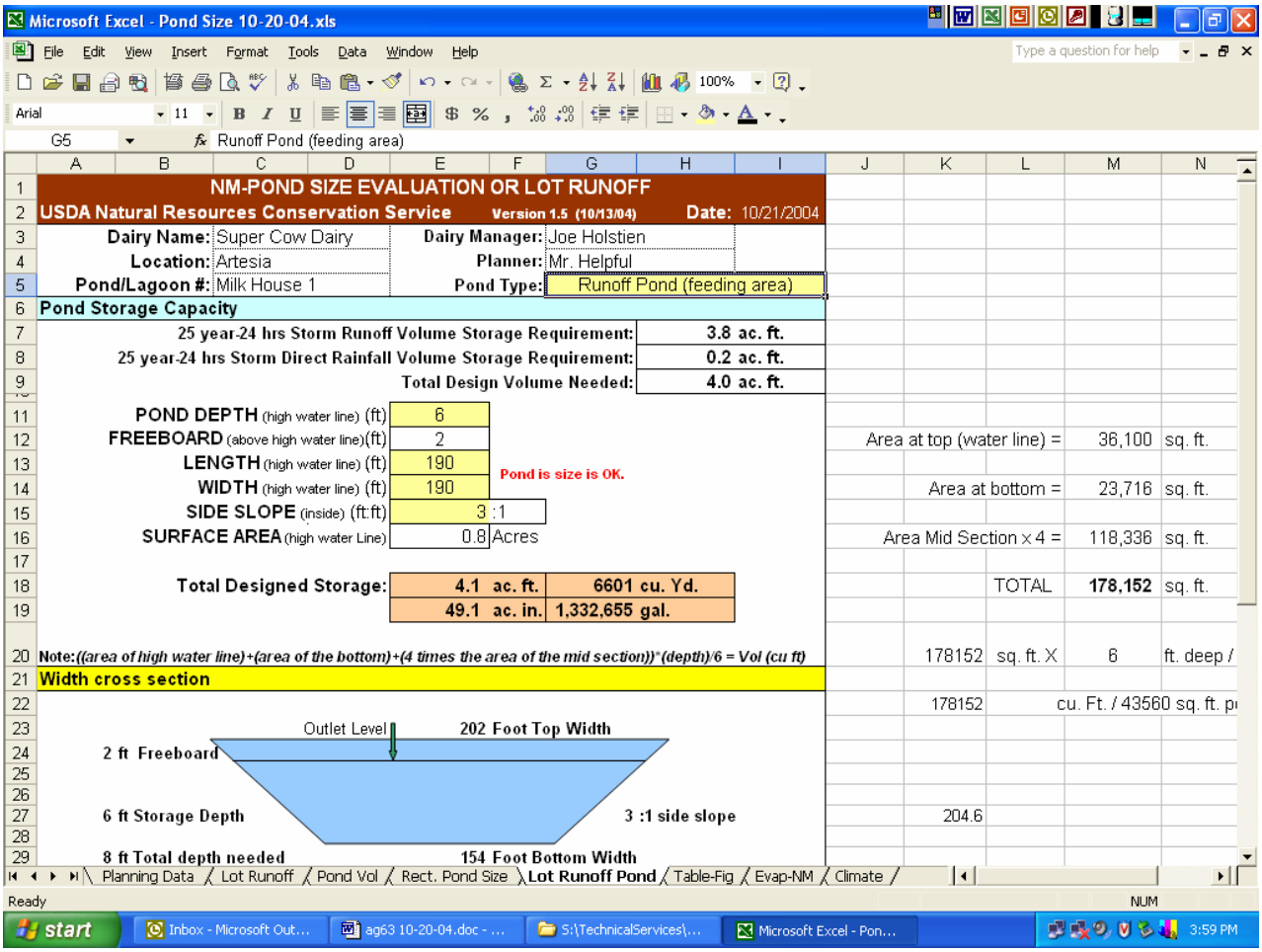
Step 9 – Print this Rect. Pond Size sheet. It is the design for the milk center pond.

Step 10 – Move to the tab for **Lot Runoff Pond**. Describe the pond type (runoff, multi-cell main, etc.). This sheet is more flexible than the Rect. Pond Size sheet and can be used to try different pond sizes and other alternative solutions. The user can alter the Lot Runoff sheet and compute alternatives. If the user tries several or many alternatives, they should print each Lot Runoff and Lot Runoff Pond sheets in order to maintain a record of each alternative.

– For our example, this sheet will size the lot runoff pond. Step 8 sized the milking center pond. For the lot runoff, it is practical to start with the previous initial depth. Therefore, enter 6 for depth. Using the same side slope, enter 3. Now, change the Length and Width to establish a computed pond volume equal to or slightly larger than the required volume, which for our example is 4.0 ac ft. A note with red lettering directs the user to increase the pond depth or dimensions, or if the computed and required volumes balance, the note indicates that the pond size is ok. A 190-foot square pond will hold the required volume. The length, width, and depth should be varied to fit the pond into existing site conditions.

– Note that the final top width and length increased to 202 feet due to freeboard requirements.

– The Construction Quantities section provides estimates for excavation volume and area of lining materials needed to construct the pond. These estimates are based on level ground across the pond location.



Step 11 – Print this Lot Runoff Pond sheet. It is the design for the pond which will contain the feeding lot runoff.